Possibilities of Quality Enhancement in Higher Education by Intensive Use of Information Technology

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Abstract

Quality of higher education is a multi-dimensional concept. It lies in effectiveness of transmitting knowledge and skill; the authenticity, content, coverage and depth of information; availability of reading/teaching materials; help in removing obstacles to learning; applicability of knowledge in solving the real life problems; fruitfulness of knowledge in personal and social domains; convergence of content and variety of knowledge over space (countries and regions) and different sections of the people; cost-effectiveness and administrative efficiency. Information technology has progressed very fast in the last three decades; it has produced equipments at affordable cost and it has now made their wider application feasible. This technology has made search, gathering, dissemination, storing, retrieval, transmission and reception of knowledge easier, cheaper and faster. Side by side, a vast virtual library vying with the library in prints has emerged and continues growing rapidly. One may hold that the e-libraries are the libraries of tomorrow when the libraries in prints will be the antiques or the archival objects of the past.

This paper discusses in details how information technology can be applied to enhance the quality of higher education at affordable cost. It also discusses the major obstacles to optimal utilization of information technology and measures to remove them.

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Introduction: It is now a commonplace knowledge that computers can be used to store, retrieve, and process and transmit data and information in large volumes at a great speed and very cheap rate. Along with it, computer hardware is progressively becoming inexpensive and affordable not only to the institutions but also to the individuals. Computer software for different applications also is now available. Side by side, over the years a growing number of persons have acquired the skill of using computers and training others how to use computers in different walks of life.

In the traditional mode of formal education the transmission of knowledge characterizes, among others, a person to person contact established so often by verbal means and sometimes by demonstration. One of the major secondary mediums of storage and transmission of knowledge is a book – a paper medium on which information is printed. Along with it, periodicals of different types, including journals and magazines, make another kind of medium. Reports, dissertations, etc are there to add to this body of the material medium. A traditional library is a collection of such large number of paper mediums. These libraries have been the nodes of knowledge accumulation and knowledge distribution for centuries now.

It may be noted that textual mode of information storage and transmission has its own limitations. There are a number of instances where pictorial or auditory representation would be appropriate (or, perhaps, necessary) and in such cases a verbal (textual) representation would be only a very poor source of knowledge. The face and complexion of a person, the appearance of a medicinal plant or the color of a chemical can only poorly be stored and transmitted through verbal means. Mona Lisa or Taj Mahal cannot be known verbally. Musical objects can hardly be presented either pictorially or verbally.

There is another mode in which knowledge is obtained as well as transmitted. That relates to learning by doing. Swimming cannot be learned in a class room. One cannot possibly understand many of the mathematical concepts and the working of formulas only by reading and reflecting on them. Some of them require to be learned only by doing, which may be very laborious and time-taking. Solution of many problems cannot be obtained analytically. In the same way, there are many machine designs that would not reveal several of their properties unless they are seen working.

The objective of this paper is to highlight the possibilities of quality enhancement in college and university education by means of an intensive application of modern advancements in

information technology. For this purpose, the paper is divided into four sections. The first section describes the modern development in the field of information technology, the second section makes an attempt to identify the parameters to define quality in education, the third section correlates developments in the information technology to the possibilities of quality enhancement in higher education and the fourth section concludes the paper.

I. Developments in Information Technology

I.1. A Brief History of Traditional Mode of Information Technology: If we look back into history, paper-making and printing were the two (among others, see Wikipedia: Four Great Inventions of Ancient China) great inventions made by China. It is generally held that paper-making technique was invented in China sometime in the 2nd Century AD, although a recent archaeological discovery has been reported (from near Dunhuang, in Gansu province of China) of paper with writing on it dating to 8th Century BC (Wikipedia). By the 8th Century AD papermaking came to the Middle-East and it entered Europe in the 12th Century through Spain. The first commercially successful paper mill in England was opened in 1588 and was initially reliant on German papermaking expertise. Until the 19th Century, when steam-driven paper making machines (that could make paper with fibres from wood pulp) were invented and became commercially operative, paper making continued to be expensive.

On the other hand, use of paper for writing became widespread in the 3rd Century AD. The Chinese went in for woodblock printing of text (books) in the 9th Century AD. Much before that, they were adept in making woodblocks of pictorial presentation of objects and printing them. They had also invented movable type printing, sometime in the 6th Century AD. It is believed that the mechanized printing technology using movable metal cast typing started in Germany sometime in the mid-15th Century. Oil-based ink, prints with which were more durable than the water-based ink, was invented. These inventions made book printing commercially viable. They revolutionized communication and book production leading to the spread of knowledge. The technique for using multiple colors in printing (chromolithography) was invented in Germany towards the end of the 18th Century.

Libraries as a store of information and knowledge have had their beginning in the antiquity. The Greeks had libraries filled with parchment and papyrus scrolls. In the 6th Century AD, the great libraries of the Mediterranean world remained those of Constantinople and Alexandria. By the 9th century completely public libraries started to appear in many Islamic cities. They were called "halls of Science". They were endowed by Islamic sects with the purpose of representing their tenets as well as promoting the dissemination of secular knowledge. The major changes in the nature and size of libraries came with the advent of mechanized paper making and printing technology. By the end of the 17th Century, the quantity of books had gone up. As the cost of

production of books had gone down, there was a renewal in the interest of classical literature and culture; nationalism was encouraging nations to build great libraries, universities were playing a more prominent role in education, and renaissance thinkers and writers were producing great works (Wikipedia, Library).

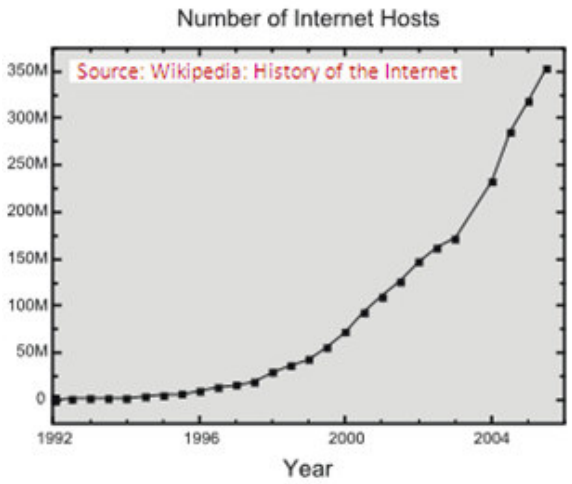
I.2. The Computer Revolution: Although one may trace back the history of invention of some sort of computer even before the World War II, the first electronic devices that resemble modern computers were designed in 1940's. Computers are programmable machines that store and execute programs or the list of instructions. These instructions are capable of activating a large number of devices in which electronic control systems are coordinated with electrical, mechanical, magnetic or such systems. The capability of a computer to store and execute programs distinguishes it from other machines.

Electronic computers initially were quite large, as much as several full size *almirahs* connected together by ropelike cables, and were mainly used for scientific computing. They were very expensive and needed very specific infrastructural facilities and technically trained personnel to keep them running. Users of those computers were few; their use was restricted to computing and most importantly users were normally not permitted to handle them. In due course of time, there were significant developments made in the field of electronic engineering and consequently integrated circuits and microprocessors were developed. A microprocessor is a single chip, a miniaturized electronic circuit consisting mainly of semiconductor devices as well as passive components that has been manufactured in the surface of a thin substrate of semiconductor material such as silicon, with all the circuitry on it to perform necessary operations. As the large scale production of microprocessors at cheap rates became possible, personal computers came to the market. This development brought the users and the machine in direct contact with each other sometime in the mid 1970's. By early 1980's personal computers became quite affordable and since then ever better machines, increasingly more powerful yet less expensive, have been hitting the market. According to Moore's law, the number of transistors that can be inexpensively placed on an integrated circuit is increasing exponentially, doubling approximately every two years, and the power of a personal computer is increasing while its price is decreasing accordingly. In the mid-1980's a personal computer commonly available in the (Indian) market was thousands of time slower; could store data less than a thirtieth of a common CD (compact disk) of today, and in real value was over 25 times costlier than a common personal computer available today. A commonly available computer today can in its secondary memory (non-portable hard disk in the system box) store over 20 thousand books of normal size.

I.3. The Advent of E-Text, E-Books and E-Documentation: It has been mentioned before that initially computers were very large, expensive, affordable only to large organizations, mainly computation-oriented and therefore used by fewer people. However, the imaginative people of the time had visualized the possibilities of application of computers in many fields. As computers grew cheaper and their users grew in number, the economies of scale and scope started showing up and the dawn of a new era was foreseeable. In 1971 Michael Hart, working on a Xerox Sigma V mainframe computer, foresaw that the greatest value created by computers would not be computing, but would be the storage, retrieval, and searching of what was stored in our libraries (Wikipedia, E-Book). The first "e-book" was born. An e-text (electronic text) is, generally, any text-based information that is available in a digitally encoded human-readable format and read by electronic means. In a very general sense, an e-text encompasses an e-book, an ezine (electronic magazine), or an internet newspaper, etc. In particular, an e-book (also called an ecobook) is the digital media equivalent of a conventional printed book. Such documents are usually read on personal computers. Textual materials could be in ASCII codes, but e-documents and e-books may be in any proprietary format and be a combination of textual, graphical, chromolithographic or any other type of audiovisual information. The concept of e-documentation revolutionized the world of information rendering and producing reading materials. Today Project Gutenberg houses 20,000 free texts and over 100,000 books are available through their partners (Wikipedia, E-Book).

I.4. Development of Portable Storage Media: Until the late 1980's the most common external and portable medium to transmit programs and data were the floppy diskettes that could store only about 1.4 megabytes or a text of little over 200 pages or so. In the late 1980's CD-R compact disks were introduced that could be written once but could be read again and again. It could store data of a size of some 50 floppy diskettes. By the end of 1990's the CD-RW disks were developed and were available in the market. Like the floppy diskettes, the CD-RW could be used for erasing and rewriting on them. Storage capacity of these compact disks was more or less the same as that of the CD-R. However, initially, the rewritable compact disks were much more expensive than the CD-R. In the early 2000's the USB flash drives (commonly called the pen drives) were introduced in the market. The USB flash drives, unlike floppy diskettes, hard disks and compact disks do not spin but are based on the solid state technology. Starting with a petty 8 MB storage capacity, now (in 2008) a pen drive of 4 GB storage capacity is considered outdated, an 8 GB pen drive is becoming common and a 32 GB pen drive is already in the market although it is expensive. Side by side, external (portable) USB hard disks of a large storage capacity (500 GB or more) are available in the market. These portable hard disks can store over 50 thousand books of an average size. It also may be noted that these drives have a volume not larger than $100\ \text{inch}^3$ and weight not more than 2 lb; sleeker and less voluminous models are available. Thus, one can carry 50 thousand books in one's pocket.

I.5. Development of the Internet and the World-Wide Web: Although the history of electronic networking (among different nodes) for information interchange dates back to 1950's, the real breakthrough of internet was made in 1960 by JCR Licklider in his January 1960 paper, Man-Computer Symbiosis, wherein he wrote: "A network of such [computers], connected to one another by wide-band communication lines [which provided] the functions of present-day libraries together with anticipated advances in information storage and retrieval and [other] symbiotic functions." (Wikipedia, History of the Internet). The idea was implemented soon and the number of internet hosts grew exponentially over time since then. During the late 1980s, the first Internet service provider (ISP) companies were formed. Today, internet is being used for writing personal letters (e-mail), e-conferencing, storing and retrieval of information on varied topics, downloading reading materials etc. The World-Wide Web access is available in almost all conscious organizations. The World-Wide Web connects the user's computer, through the internet-provider's server, to the server wherein information lies stored. The link is established through a web browser that operates on the user's computer. A web browser is a software application which enables a user to display and interact with text, images, videos, music and other information typically located on a Web page at a website on the World Wide Web or a local area network. The web access can be made even in small towns (in Cyber Cafes).



Text, images and audible materials on a web page can contain hyperlinks to other web pages at the same or different website. Web browsers allow a user a quick and easy access to information provided on many web pages at many websites by traversing these links (Wikipedia, Web Browsers). Many internet browsers are used these days, the Internet Explorer (of the Microsoft), the Netscape Navigator, Conqueror, Opera and Mozilla to name a few of them.

Associated with the World-Wide Web are the web search engines that can search and list the web connections and web pages in which the information searched by the user appears. The user has to give a few keywords and the web search engine scans through the web pages crawled (indexed) by it and list those web pages that are connected to the web and contain those keywords. A large number of search engines are at service today; Google, Yahoo, Baidu, NHN, e-Bay, AlltheWeb, and Ask.com to name a few of them. There are a number of meta-search engines also. These meta-search engines use several search engines for searching the query or the keywords given by the user, process the results of search made by various search

engines and present the web pages containing those keywords. The advantage of using a meta-search engine is that it coordinates several web search engines and the web pages not covered (crawled or indexed) by the one search engine but crawled by some other search engine are not ignored. Meta-search engines operate on the premises that the Web is too large for any one search engine to index it all and that more comprehensive search results can be obtained by combining the results from several search engines. This also may save the user from having to use multiple search engines separately (Wikipedia, Meta-search Engine). Dogpile, Vivisimo, Kartoo, Mamma, and SurfWax are some of the prominent meta-search engines.

Almost all organizations that care to be observed and noted by others today make their websites and get them hosted (very large organizations may host themselves) so as to be linked to the World-Wide Web and indexed by the major search engines. These organizations make and maintain their web pages that contain the information which may attract others (target group) to them. Individuals also make their web sites and get them hosted by some internet hosting organizations either on payment basis (which is quite small an amount) or for free. Indeed there are numerous such hosts that extend these facilities to the individuals without any payment. The Freewebs.com, the Webng.com, Yahoo, Tripod.com, etc are such hosts.

I.6. Development of E-Libraries and Electronic Encyclopedias: The e-libraries are a collection of e-documents and e-books stored in a server computer (or a collection of servers connected through e-network). The e-library may be meant for the restricted use (by an individual or an organization) or for the public use either on a payment basis or for free. When an e-library is meant to be used by any (unidentified) person or organization, then it is connected to the World-Wide Web so that anyone can access it through the internet. Such e-libraries have been developed by many organizations and their sizes are continuously increasing. As it has been mentioned earlier, Project Gutenberg houses 20,000 free texts and over 100,000 books are available through their partners. These books can be downloaded free of charge through the internet. Most of these books are the classics in different disciplines. Over 3,000,000 books are downloaded each month from the Project Gutenberg website. There are many organizations that have developed discipline-specific (or author specific) e-libraries accessible through the internet. Most of the publishers that ran paper-based (printed) journals and magazine/periodicals continue to do so, but they have also gone in for e-version of the same. Many publishers have also gone in to make the e-version of back volumes of their journals. Numerous organizations provide facilities to the authors to store their pre-print manuscript as well as the copies of the published research papers for archiving, which are connected to the World-Wide Web. The culture of e-publishing of working papers and making them available to the readers through internet is spreading very fast. It has now reached the level at which one can find a number of good documents/papers on almost any topic in any discipline. For

example, the Social Science Network e-Library (mainly relating to economics and associated disciplines of social sciences) consists of two parts: an Abstract Database containing abstracts on over 185 thousand scholarly working papers and forthcoming papers and an Electronic Paper Collection currently containing over 148 thousand downloadable full text documents in Adobe Acrobat PDF format. Most of these papers can be downloaded for free. The EconPapers (relating to economics) provides access to over 179 thousand working papers, 298 thousand journal articles, about 1 thousand books, about 2 thousand book chapters, all in PDF format, and about 1.6 thousand software items, all downloadable through internet. There are many similar, but possibly smaller e-libraries and portals in economics alone. Similar e-libraries and portals exist for other disciplines also.

Many electronic encyclopedias have come up and they may be accessed through the internet. Unlike the printed encyclopedias that are very costly and bulky, and it is time-taking to search out and retrieve information from them, the electronic encyclopedias can be accessed in seconds by providing a few keywords on almost any subject. It does not have any cost except the charges for using an internet, which is as cheap as Rs. 10 per hour in any Cyber Café (in India). Wikipedia, which is liberally used for writing this paper (and without which this paper could not, perhaps, have been written), is one of such encyclopedias which are information-rich and evolving every day. Anybody who accesses Wikipedia would certainly be amazed and overwhelmed by the resources made available to him or her. To benefit from them, one needs only a computer and an internet connection or an access to a Cyber Café.

I.7. Development of Software for Scientific Computation: Many sciences use mathematics or mathematical methods rather liberally. Sometimes, when the problems are simpler, it is possible to obtain solutions analytically or manually. However, oftentimes it is not so. Many problems use data or computation heavily and the nature (or behavior) of such problems cannot be obtained analytically or by reflective thinking or they cannot be worked out manually. To solve such problems we use computers. Solving problems numerically with the help of computer gives us the results on the one hand and help to understand the nature of those problems on the other. Oftentimes computers are used to simulate real life complex problems and study their behavior by changing the parameters. Such simulation experiments are necessary since it would not be possible to deal with the real life problems for the purpose of experimentation. Scientists develop software to solve such problems which may be obtained free of cost or on payment basis. In any case, these software or programs can be obtained in working condition and other scientists need not develop them de novo. It saves time, adds to efficiency and reduces the chances of committing mistakes.

II. Quality in Higher Education

In this paper we mean by higher education the tertiary or after-school formal education imparted to the students in colleges and universities (including various institutes). However, we require a discussion as to the quality in education.

II.1. Parameters of Quality in Higher Education: A general agreement on all the parameters may not be there, but the following aspects of quality may be acceptable to all.

i). *Richness in Knowledge and Skill*: Perhaps the most important parameter of quality in higher education relates to absorption of knowledge and generation of skill among the students. A recipient of higher education in the formal system conventionally chooses a set of disciplines, which, at a given time, have a body of extant information and knowledge as well as a level of skill at using those information and knowledge to practical applications. A college student, having completed his/her studies, is supposed to have acquired a subset of those extant information and knowledge and use them in practical applications. A university graduate, similarly, is expected to be well versed in a larger subset of the said body of information, knowledge and skill, and a doctorate degree holder is supposed to command a still larger subset. In this respect quality refers to the level of achievement of the graduate vis-à-vis the norm set (or adopted) by the institution imparting higher education. This entails the 'fitness for the purpose' criterion.

It may be noted, however, that the method and content of imparting education are not the sole determinants of achievement of a graduate student; his/her personal traits and efforts also are important. When education is imparted to many students, the positive and negative effects of personal traits and efforts (or a lack thereof) may even out so as to reflect the effective contribution of education to the average level of achievement of a mass of students.

At this juncture, we face an important question. Who decides and what determines the norm to be referenced in evaluation of the average level of achievement of a mass of students? Conventionally, teachers or a body of experts set those norms, which is reflected in the syllabi governing the subject matter to be taught to the students, and the examination system evaluates the achievement of the pupils. At the research level of education, the supervisor and the experts determine the norm and evaluate the research students. In turn, the information, knowledge and skill of teachers and experts have an effect on setting of norms. If they are themselves ill informed, less knowledgeable and poor at skills, it cannot be expected that they would set the norms commensurate with the demands of the discipline and the need of the society. Thus the average level achievement of the body of experts (and teachers) determines the norms of quality.

Availability of reading materials and teaching aid is the next determinant of norms as well as the average level of achievement of experts, teachers and students. That is why one must appreciate the role of books, journals, documents and the libraries in determining the quality in higher education. Two important aspects of availability of reading materials and teaching aid must be considered; the first relating to the quality and the second relating to quantity. That is to say that availability of high quality teaching aid and reading materials enough in quantity so as to make them accessible to each and every participant in the educational process without much effort and delay would improve the quality of education. Availability of high quality reading materials helps the teachers as well the students to have a better grasp of the subject matter, critical attitude, innovative tendencies and lucid communication skills.

It is important to note that the real world evolves continuously working under the law of cumulative causation in which quality begets further higher quality and degeneration leads to further degeneration unless interrupted by a powerful shock of constructive destruction that is potent enough to change the said course of movement. Exposure to the events occurring elsewhere, innovations and their beneficial applications taking place outside and the success (or failure) stories of others may stimulate one to change one's course. Availability of reading materials of high quality tends to prepare an environment suitable to such changes and, consequently, facilitate a movement upward towards a better quality of education.

ii). *Relevance*: The second most important parameter of quality is the appropriateness and relevance of the information, knowledge and skill imparted by education to the current and the foreseeable techno-economic and social needs and priorities of the nation (as well as the region) that supports the educational system. If higher education does not have some concordance to the said needs and priorities, we would hesitate to appreciate its quality even if it is Okayed on the first principle laid down earlier. UNESCO (1998) rightly views that quality "reflects national, regional and global socio-economic, cultural and political visions".

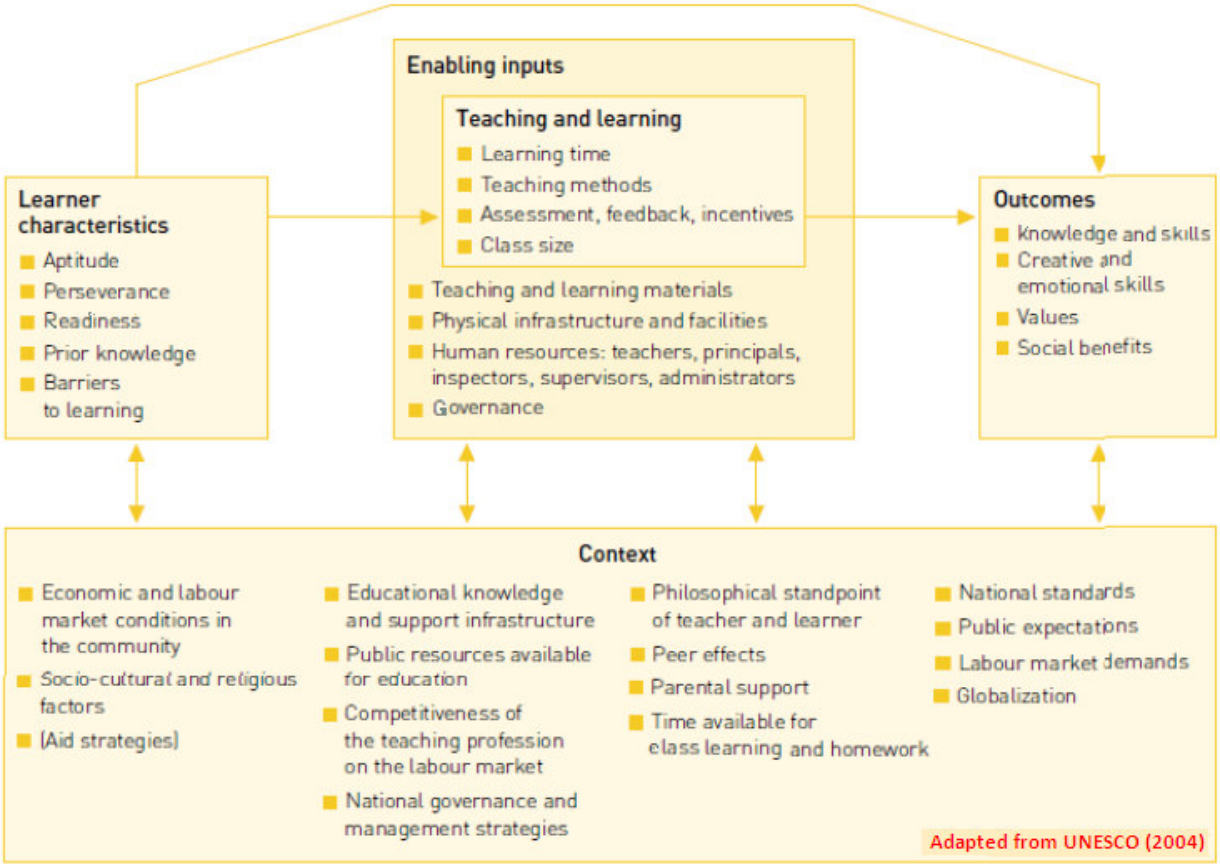
iii). *Creativity*: The two parameters of quality (in education) mentioned above often join with the characteristics of students and under favorable conditions lead them to gain courage of facing challenges and conquering the adversities. Inculcation of problem solving ability, creativity, innovativeness and such faculties make the third parameter of quality in education. A poor quality of education discourages and subverts these faculties.

iv). *Sublime Values*: Nevertheless, there is some sort of conflict between the first two parameters deliberated above. The personal priorities of a college or university graduate of very high quality judged on the first criterion may not be conformal to the priorities of the nation or the regions that imparted excellent education to him/her (Dey, 2000). Or even the

priorities of a discipline judged on international norms might be quite unsuitable to the national/regional techno-economic and social needs.

In order to resolve the conflict pointed out above, it requires the fourth important parameter to be spelt out. Education must inculcate among the graduates certain values such as to appreciate the importance of commitment, cooperation and compassion in making competence creditable. One must understand that in making us what we are today there is a great role of sincere efforts of many whom we know and many others whom we know not. We are indebted to them and the burden of this debt can only be lightened if we sincerely reciprocate and give unto those who live with us and will live after us. We have to move fast to a "give-and-take" culture in which we are not only receiving ideas from others; we have also to contribute to the ever growing store of knowledge for the benefit of the entire humanity. These values are absolutely necessary for the establishment, functionality and development of a knowledge-based society towards which we are progressing steadily.

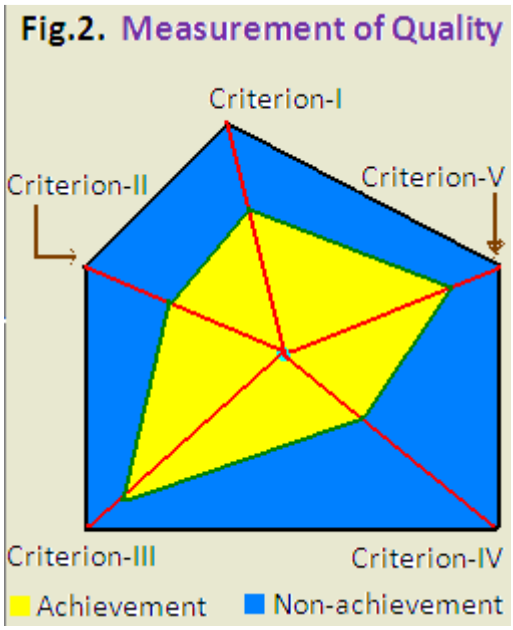
Fig.1. A Framework for Understanding Educational Quality



v). *Cost-effectiveness*: The fifth parameter of quality of education is its cost effectiveness. If two kinds of educational process assure the same quality but they differ in the cost incurred in attaining it, then the less expensive educational process is obviously better than its expensive alternative. After all, resources have multiple uses and every use has its opportunity cost.

The conceptualization of a framework for understanding educational quality has been succinctly put forth by the UNESCO (2004) which we present in Fig.1, although with some minor alteration.

II.2. A Proposed Measure of Quality in Higher Education: One may devise an index, a quantitative measure, of attainment along each one of the five criteria of judgment on quality in higher education. Such indices may, in turn, be based on a fusion of numerous variables measured quantitatively on some sort of scale. If one devises a seven-point scale then one can judge as to the attainment of quality along a particular ray of criterion elaborated above. A judgment on relative relevance may also help determine the relative weights that may be assigned to different criteria. Then one may conceptualize a measure of the overall quality of attainment as graphically depicted in Fig.2.



Graphically, a polygon is produced by the criteria of quality measured along the rays joining the center and the vertices of the polygon. The relative length of each ray is determined in accordance with the relevance that it is visualized to have. The rays are positioned so as to give the maximum area of the polygon. For instance, ray-I may be the left-adjacent to ray-III and right-adjacent to ray-V and so on. It may require some combinatorial exercise to do that. Then achievement may be measured along each ray and the point on each ray may be joined to the points on the left-adjacent and right-adjacent rays. This exercise would inscribe a polygon of achievement within the larger polygon and will have an area.

Then, the overall quality may be measured as a ratio of the area of achievement to the area of the larger polygon (super-scribing the polygon of achievement). This measure will always lie between zero and unity. It may be noted, however, that this method of measuring quality is not the only method to do that; there could be different (and possibly better) alternatives to measurement of quality.

III. Modern Information Technology and Quality in Higher Education

We have already reviewed what the modern information technology has made feasible. Now we have to elaborate on the possibilities that it has created to enhancement of quality in higher education.

III.1. Possibilities in Enrichment of Information, Knowledge and Skill: The modern information technology has greatly extended the possibilities of enrichment of information, knowledge and skill. Development of e-books, e-journals, e-libraries, e-encyclopedias, e-photography, electronic audio-visual aid, etc has opened up a world of possibilities before us. Internet can be used to download a variety of reading materials, often illustrated by means of audio-visual aid. Illustration may be static with different color schemes or dynamic with the use of animation. Thousands of books, if in e-form, can be scanned to search and retrieve the required information in no time. Scores of thousands of books can be carried in a small external hard disk or a laptop computer and they can be copied on to other storage devices. Student can store in a pen drive all their textbooks covering the entire syllabus for a semester or even for two years' program.

Internet and the World-Wide Web have opened up the entire world for the seekers of information. Now we need not depend on the availability of printed books in the traditional libraries. Visiting traditional libraries, searching the right type of book, reading its content, taking notes, etc are now the practice of the olden world. Internet can give us an access to any library in the world if it exists on a node of the World-Wide Web. The teaching materials posted on the website by a professor teaching in MIT or Harvard can be accessed by a student in India Indonesia or Ireland alike. Thus it helps in reducing the knowledge and skill gap among the regions and the nations and consequently fostering greater equalities in socioeconomic and technological opportunities and achievements.

The role of information technology for promoting quality in higher education has been widely acknowledged. Savenije (2000) observes: "Modern information technology can and must be deployed to bring the library closer to scientists, teachers and students, in terms of both space and content." Johnson and Luther (2007) observe: "As academic librarians, publishers, authors of research articles, and readers of journals well know, journals began a profound and ongoing makeover with the arrival of the World Wide Web. Technological, economic, and human factors are transforming both journals and the broader process of scholarly communication." They also predict that e-journals are the journals of the future while printed journals will be the things of the past. Higher education system must go along to keep itself abreast with this development.

The National Knowledge Commission (Govt. of India, 2008) acknowledges the importance of information technology for quality in higher education. It recommends the use of modern information and communication technology to meet the changing needs of the library and information services (LIS) and strengthen the institutional framework of libraries, networking, LIS education, training and research, modernization and computerization of libraries, maintenance of private and personal collections, etc. It proposes that the "catalogues of all libraries should be put on local, state and national websites with necessary linkages. This will enable networking of different types of libraries and setting up of a National Repository of Bibliographic Records and a centralized collaborative virtual enquiry-handling system using the latest information and communication technology (ICT). To enable equitable and universal access to knowledge resources, libraries should be encouraged to create more digital resources by digitizing relevant reading material in different languages, which can be shared at all levels. Peer-reviewed research papers resulting from publicly funded research should also be made available through open access channels, subject to copyright regulations. It is recommended that open standards and free and open source software may be used for the above. It is particularly important to enhance the ICT infrastructure. Websites and web based services would improve transparency and accountability. A portal on higher education and research would increase interaction and accessibility. A knowledge network would connect all universities and colleges for online open resources."

III.2. Removing Obstacles to Learning: A variety of software and soft-ware based teaching aid are available now. Software can read out the text loudly (if, for example, the text is in the PDF format and the Acrobat reader is used) and thus visually impaired persons can also 'read' the text without the help of Brail or a human reader assisting them. There are a number of software programs that teach mathematical concepts, numerical methods, problem solving and such arts step by step. Certain exercises that earlier were highly labor and time consuming and error prone too, can now be done and redone within no time to get at them.

III.3. Support to Creativity: Teachers can search out on the relevant web sites the reading materials best suited to their students and hyperlink those websites in their own web pages (e.g. visit http://www.webng.com/economics). They can compile, edit, write, illustrate, vocalize and animate the illustrations so as to make the reading materials rich, lively and student-friendly, and post them on web pages that may help not only their own students but the students anywhere in the world. This is being done vigorously in the West, but India is still lagging much behind the more developed and web-conscious nations.

Research students can now easily scan through the contents of journals relevant to them. They can contact the experts via e-mail, arrange an e-conference and discuss their findings with them. They can also ventilate their ideas to others and benefit by the comments and observations made by others living far away in the distant lands.

Wikipedia as a means to collaborative learning has been widely acknowledged. Ebnor et al. (2008) observe that "… wikis are increasingly used for educational purposes. Basically, the most important asset of wikis is free and easy access for end users: everybody can contribute, comment and edit - following the principles of Universal access. Consequently, wikis are ideally suited for collaborative learning and a number of studies reported a great success of wikis in terms of active participation, collaboration, and a rapidly growing content." Wikipedia presents before us the possibilities of an evolving "give-and-take" generation.

III.4. Removing Obstacles to Creativity: One may note that the traditional method of ventilation of one's ideas through printed journals is not only outdated, costly, time-taking and restrictive; it is also so often biased (Hamermesh, 1994; Laband and Piette, 1994; Laband, 1985). The referee system does not always work in favor of a healthy development of science (Frey, 2002; Gans and George, 1994, Hamer). The journals and the referees have their own biases (Vandermeulen, 1972). This bias of the traditional method against putting on record one's own scientific ideas and findings can be overcome by the use of the internet which allows web publishing. Archives that publish working papers on their web pages are also useful.

III.5. Adding to Relevance of Education: Initially land and other natural endowments were the most important sources of social and economic development of the nations/people. After the Industrial Revolution, manufacturing and therefore physical capital overtook the prominence of agriculture and remained in throne for centuries. However, for a century now, the role of education in shaping development has come into the forefront. Education has been the major contributor to making of the human capital, and thus it has been the most important factor in promoting growth and welfare of the modern society. However, it may be noted that natural endowments and human resources as well as the historical forces together with social institutions of a region/nation determine as to the kind of knowledge which would be more suitable to attain a higher level of development with social wellbeing. This is to say that different regions/nations have different kinds of knowledge and skill appropriate and suitable to them. The people who can visualize the knowledge and skill requirements of a specific society (intelligentsia) can also plan for a suitable educational policy, write extensively to mould the public opinion in favor of such knowledge and skill, create and disseminate knowledge and give direction to others for creating relevant knowledge. Conventionally it has been done through the printed media and personal contacts. The modern information technology can help in a great way to promote such activities fast and inexpensively with much larger coverage and better appeal. As the impact of television is much more than the older newspaper based or radio-based media, so will be the impact of education if it is based on the modern information technology. Take for example the role of television in spreading health consciousness and exercises based on yoga. It could not possibly have been so effective if it were spread through

books and radio programs. Any mode of dissemination of knowledge that engages more number of sense organs to transmit information is more effective than the alternative mode that engages a fewer number of sense organs. A television (or any mode of relaying audiovisual plus textual information together) uses more number of sense organs (eyes, ear, mental capacity to read) than a textbook or a radio broadcast that (often) uses only one of them.

The National Knowledge Commission (Govt. of India) has highlighted the importance of various national web based portals on key sectors such as Water, Energy, Environment, Education, Food, Health, Agriculture, Employment, Citizens Rights etc. It has been recommended that these portals would serve as a single window for information on the given sector for all stakeholders, from students to researchers and practitioners in the field. The higher education system must tune itself to use these portals to improve and maintain quality in terms of relevance in addressing the technical, social and economic problems.

III.6. Cost-Effectiveness of and IT-based Educational Materials: Electronic documents (e-books, journal articles, etc) are very easy and inexpensive to search, download, duplicate and distribute. Communication by e-mail is extremely fast and inexpensive. It is easy to arrange e-conferences. Storage of e-materials is extremely space-saving, resource-saving and safe. It is also aligned to the benefits of the paperless economy with far-reaching favorable effects in terms of saving energy and environment.

III.7. Favorable Effects on Cooperation, Empathy and Compassion: Partly due to its inexpensive nature and a new "give-and-take" culture emerging due to the spread of the IT-based culture, there is an increased sense of reciprocation, coordination, empathy and compassion among the scholars working in and across different disciplines. Information technology has given rise to the 'blog" culture which has proved to be very effective in solving problems of those who participate in it. A participant posts a problem on the 'blog page' and numerous others respond to solve the problem. A new culture of crowd-sourcing is emerging. This culture is based on the premise that the urge to solve the problem of others is not tied with the expectation of any material gain except the satisfaction derived from solving the problems and, occasionally, an acknowledgment of appreciation for doing so. It has also been found that use of IT methods for educational and research purpose promotes the sense of value of time, mutual dependence, reciprocation and cooperation. Although carried out with the expectation of long-run gains, IT professionals and firms provide many software/programs free of cost to the users. It may be noted that while many of us want to read, there are many who aspire for being read. The IT culture has brought them together for gratification of both the desires. It has also been found that due to increased visibility the e-based reading materials are read and referred more frequently than the print-based reading materials.

IV. Conclusion

Quality in higher education entails effectiveness of transmitting knowledge and skill, the authenticity, content, coverage and depth of information, availability of reading/teaching materials, reduced obstacles to learning, applicability of knowledge in solving the real life problems, fruitfulness of knowledge in personal and social domains, convergence of content and variety of knowledge over space (countries and regions) and different sections of the people and realization of cost-effectiveness and administrative efficiency. As the information technology has progressed very fast in the last three decades, it has produced equipments at affordable cost and it has now made their wider application feasible. This technology has made search, gathering, dissemination, storing, retrieval, transmission and reception of knowledge easier, faster and inexpensive. Side by side, a vast virtual library vying with the library in prints has emerged and continues growing rapidly. It may be held that the e-libraries are the libraries of tomorrow when the libraries in prints will be the antiques or the archival objects of the past. An effective exploitation of these opportunities created by the recent advancements in information technology may significantly improve quality in higher education.

Quality in higher education also requires effective governance. Unless governance is apt, alert, vigilant, concerned and result-oriented, infrastructural development and availability of reading materials, etc will continue to be sub-optimally utilized. Fortunately, information technology can also be used to strengthen the governance of higher education. First of all, exposure to and working with the modern system based on information technology promote a clearer conception of organizational framework. Application of information technology changes the worldview and the mindset of the people. This changed worldview and mindset goes a long way to systematize the working environment. Knowing is the first step to governing. A clearer conception of the organizational framework promotes building a richer data base, more efficient retrieval of information as well as apt and timely monitoring. Improved monitoring promotes clarity of objectives and goals as well as the sense of responsibility in the entire system. As a result, quality improvement takes place.

At present most of the institutions of higher learning in India use information technology only nominally. This is reflected in the websites of those institutions. As a matter of fact, many institutions do not have a presence on the World-Wide Web. Those having the said presence, seldom post up-to-date information on the web pages. Information posted on the web pages is skeletal and minimal. None would visit those sites for the second time since there is nothing that may induce one to revisit them. The potentials of websites for educational purposes are unknown to such institutions. Most of institutions have progressed poorly to digitize their libraries. They do not have necessary infrastructure and manifest will to harness the potentials

of information technology for improving quality in education. There is no systematic program to sensitize teachers and students to use the modern methods of information seeking and information using. The process of teaching/learning continues to be traditional and mostly ineffective. Courses of studies continue to be outdated and oblivious to the changing needs of the society. Teachers in general do not have any will or commitment either to the discipline they teach or to the problems of the society that need their attention. In many institutions where computers and internet facilities are available, people do not know what to do with them except sending e-mails occasionally and playing games or typing letters frequently. This is a sad affair.

There is a need, therefore, that the institutions of higher learning should organize programs to train the teachers, the office staff and the students to harness the modern advances in information technology to enrich the teaching/learning process so as to improve the quality in education. The training program should highlight the possible applications of computers, internet, World-Wide Web, educational portals, websites of reputed institutions, available e-libraries and e-based encyclopedias, websites that permit a free download of educational materials, useful computer programs and software, etc. Educational Institutions should be web-conscious and make their websites so as to be used for educational purposes rather than posting stale and skeletal information on them as many of them have been presently doing.

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